Employment (MBIE), which went towards developing a small animal version.

In late 2014, the MBIE awarded $12 million for research into a human-sized version of the MARS – meaning the scanner has received more than $20 million in direct Government funding over more than a decade.

The Butlers point out that the funding figures don't include university support through student scholarships, staff time and access to equipment. University-sourced funding is comparable to that provided by Government, Phil Butler says.

While the Butlers acknowledge there are many applications for the MARS, their work has focused on medicine.

"We've had to work more closely with the medical researchers who have brought their own skill sets," says Anthony Butler.

"So we've been working with people who look at blood vessels or atheromas [when degenerative material accumulates in artery walls] or vascular disease, and particularly around strokes and the blood vessels in the neck. We've been working with cancer researchers, and we've been working a lot with people on joint implants and metal implants for knee replacements and cartilage health. But there are dozens of other applications."

As a result of research, the MARS project has spawned a commercialisation spin-off company, Mars Bioimaging Ltd (MBI). Founded by the Butlers in 2007, the company has sold six MARS devices for about $500,000 each, with two going to the US, three to Europe, and one staying in New Zealand.

A human-sized version of the MARS is expected to be built by – or possibly before – 2020, Butler says.

The father-son team are also founding members of the Medipix-3 collaboration, which has seen 24 institutions across the globe join forces on X-ray imaging research.

In addition, researchers from institutions including Yale and the Mayo Clinic have collaborated on the MARS, while other researchers and scientists regularly visit.

Domestically, there are plans to use the MARS to look at brain disease in sheep, in collaboration with Lincoln University.

Dr Nigel Johnson, the University of Canterbury's director of Research & Innovation, says there are now exciting opportunities to develop and manufacture key componentry for human scanners.

"It is taking a large research team from numerous institutions to pull this off, and we are fortunate to have had strong support from New Zealand government agencies."

Pruning vines – by robot

Canterbury vine-cutting machine ready for first field tests

A VINE-PRUNING robot being developed at two South Island universities has the potential to save New Zealand wine producers millions of dollars each year. Too bad robots can't drink.

The New Zealand vine-pruning season is often unpleasant, weather-wise. It can be numbingly cold, not to mention wet enough to almost completely eliminate the need to take a shower. Not exactly ideal conditions in which to work in a vineyard for several hours a day.

Fortunately, people might not have to be subjected to such misery in the future, thanks to a vine-pruning robot that's been developed by the University of Canterbury (UC) and Lincoln University and is set to be tested in fields for the first time during the upcoming pruning season.

"The advantage of this is it doesn't matter whether it's sunny or the middle of the night,

Cunning cutting
The vine-pruning robot uses cameras, lasers, 3D modelling and complicated mathematical algorithms to work out exactly where to prune each branch.
The University of Canterbury development team includes Dr Tom Botterill (pictured, previous page) and Dr Richard Green (left).

raining or blowing a gale," says Dr Richard Green, associate professor of computer science and software engineering at the University of Canterbury, who has been one of the key figures involved in the robot's development. "This can work 24/7 in any weather."

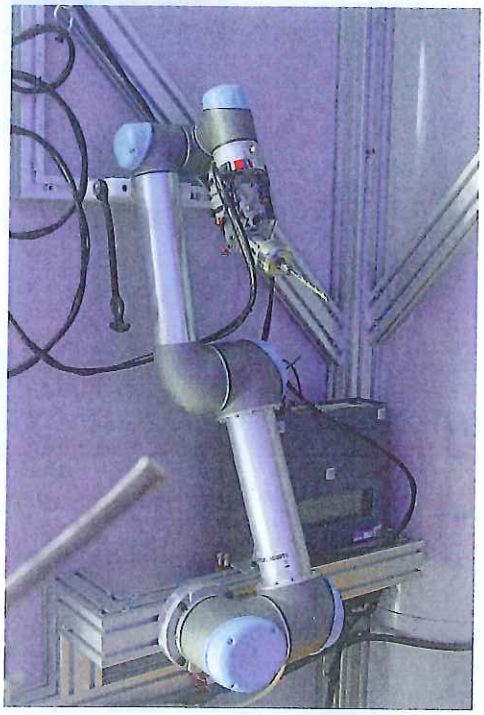
Using lasers and three built-in cameras, plus a generator for power, the robot creates a 3D computer model of a vine. Then, with a series of mathematical algorithms, the robot can determine how to navigate around the vine and whether to make a cut, using a long arm which can be fitted with either pruning shears or a rotary bit.

While one may think such complicated mathematical equations and physical manoeuvring might mean it would take the robot far longer than a human to perform a simple pruning task, Green says the robot can make the decision to cut a vine in about 1/30th of a second.

"So most of the time it's building up a 3D model," explains Green. "And it's when it's got that 3D model of the entire plant, then it can run some artificial intelligence algorithms and tell the robot arm where to cut and not to cut. And the robot arm makes those cuts very quickly, probably faster than a human can move."

A number of UC professors, researchers, and students have been involved in developing the robot, focusing on such areas as perfecting its algorithms and fine-tuning the computer software that instructs the robot what to do and when. Staff from Lincoln University have provided viticulture expertise, advising on what constitutes a quality cut when pruning vines for grapes that will be used in wine.

"We've had quite a few fourth-year students working at various times on the technology," says Green. "We've got software engineers because there's a huge amount of software engineering in this. It's not just throwing a few algorithms together."



"The advantage of the robot is it doesn't matter whether it's sunny or the middle of the night, raining or blowing a gale."

Work on the robot began in 2010, when Canterbury professor Dr Dean Kirk – who grew up on a vineyard – was contacted by the viticulture industry.

"They have a really big problem in terms of getting enough labour to prune their vines to a sufficient quality," says Green. "They just can't get enough people. They've had to spend over half their money on unskilled labour. And every mistake a pruner makes affects the quality and yield of the plant for the next two years."

In 2011 the first robot – simply dubbed "Version 1" – was ready. In 2012, final year Canterbury electrical engineering student Samuel Corbett-Davies won a top Kiwi enginnering innovation award for his work on the robot's artificial intelligence.

And in 2013, Version 1 was replaced with Version 2, complete with the improved artificial intelligence learned from Corbett-Davies' work and innumerable trials.

Green says the robot could also be used for other agricultural tasks, such as pruning fruit trees.

"This is quite a complex task that you wouldn't have a robot do in a factory, for example," he says. "In a factory the path is always the same every time down the production line. For a vine, the path is different for every single vine."

Green estimates productivity savings for the New Zealand wine industry of at least $200 million within 10 years of the robot becoming widely used. For this reason, a number of organisations have supported the robot research into the robot. The MBIE provided a $3m grant, and engineering firm Scott Technology (which develops image-based robotic systems), the New Zealand Wine Growers Association, and Pernod Ricard NZ – the largest wine and spirit company here – have all been involved.

"This is a great example of targeted research, where our academic researchers and their students have combined with end-users and a commercial manufacturer at the outset of the project," says Dr Nigel Johnson, Canterbury University's director of Research & Innovation. "The goal is incredibly challenging, but we are well on the way to reducing the pruning problems faced by New Zealand's wine growers, and generating exports of locally manufactured robots."

Idealog's Emerging Talent section combines great stories about innovation at an early-stage of commercialisation, with words and photos by an emerging writer and photographer. In this case, the words were written by Canterbury University journalism student Ben Mack and the photographers were Graeden Meek and Ashleigh Monk.